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Document Name: WQA S-200: Water Filters

CFR Section(s): 24 CFR 200, Subpart S

Standards Body: Water Quality Association

Official Incorporator:
THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

S-200

RECOMMENDED INDUSTRY STANDARDS FOR HOUSEHOLD & COMMERCIAL WATER FILTERS

A Voluntary Industry Standard

Water Quality Association®

WATER QUALITY ASSOCIATION

A not-for-profit international trade association representing firms and individuals engaged in the design, manufacture, production, distribution and sale of equipment, products, supplies and services for providing quality water for specific uses in residential, commercial, industrial and institutional establishments. Membership is voluntary.

One of the basic purposes of WQA is to promote the acceptance and use of industry equipment, products, and services. Activities, programs and services are designed to enable the industry to perform with the greatest economy and efficiency and to provide the greatest service to the public. The benefits of this shared experience accrue to all, and might otherwise be unobtainable.

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Printed in the United States of America

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INDUSTRY STANDARD FOR HOUSEHOLD & COMMERCIAL WATER FILTERS

OBJECTIVE: The objective of these recommendations is to provide a standard of design, construction, performance and service for installed new household, commercial and portable exchange water filters.

I. CLASSIFICATION AND DEFINITIONS.

A. CLASSIFICATIONS - Although filtration is basically a solids removal process, certain filter media also have other usable properties, for example, chemical and adsorptive. For the purpose of this Standard, filters of the Mechanical, Adsorptive, Oxidizing and Neutralizing types are classified as follows:

1. HOUSEHOLD – Household water filters are connected to the water system with conventional plumbing fittings, are designed for intermittent household use at service flow rates of at least 1/2 gpm for single point of use applications, at least 4 gpm for full line service, but no more than 16 gpm.
2. COMMERCIAL – Commercial filters are connected to the water system with conventional plumbing fittings, are designed for commercial, institutional and light industrial applications at flow rates up to 250 gpm and are designed for backwashing or servicing in place.
3. PORTABLE EXCHANGE – Portable exchange filters are connected to the water system with special fittings designed for easy connection and disconnection. These filters do not include valving or controls for regeneration or backwashing and are disconnected and transported to a central station or plant for regeneration or servicing. Filters for household applications are designed for service flow rates of at least 1/2 gpm for single point of use applications and at least 4 gpm for full line service. Filters used for commercial, institutional or light industrial applications shall meet manufacturers specified flow ratings.

B. DEFINITIONS.

1. Adsorption – The physical, electrostatic, surface attraction of an adsorbent for molecules of a gas, liquid, dissolved or suspended substance.
2. Backwash – The function of providing reverse flow to waste for media cleansing.
3. Bypass – A connection or a valve system that allows raw water to be supplied to the water system while the water filter is being cleaned or media changed or serviced in any manner.
4. Capacity – The length of time or total gallons delivered between servicing of the media, i.e., cleaning regeneration, replacement, as specified by the manufacturer under standard WCF test conditions. (Synonymous with In-Service Life.)
5. Cartridge – Any removable pre-formed or pre-packaged component, containing the filter media.
6. Collectors – (See Distributors)
7. Color Throw – The imparting of color by any part of a water filter to the effluent during any stage of the operating cycle.
8. Corrosion – The attack by water on any part of a water system, causing the deterioration of metal parts. This would include such noticeable effects of corrosion as leakage, flow stoppage, valve failure, discoloration, etc.
9. Cubic Foot – The volumetric unit used for measuring quantity of loose media materials. Volume is measure on an in-place, backwashed, drained and settled condition.
10. Distributors – Devices to distribute or collect the water while retaining media in the filter.
11. Downflow – A term applied to designate the direction (down) in which water flows through a filter during any phase of the operating cycle of a water filter.
12. Drain Line – A line used to carry backwash water, spent regenerant and rinse water to a waste system.
13. Effluent – The water or solution which emerges from a filter during any phase of the operating cycle.
14. Filter – Device consisting of a container, media and necessary controls to accomplish the removal of undesirable substances.

15. Filter Area – The effective area through which water approaches the filter media, usually expressed in square feet.
16. Filter Medium – (Filter Media) See Medium.
17. Filtration – Process for clarifying water by passing it through a filter medium or filter media to remove undesirable particulate suspended matter. The term filtration in these standards may be combined with other processes to accomplish the removal of undesirable substances, i.e., adsorption, oxidation and neutralization.
18. Flow Rate – The quantity of water and/or regenerant flowing, measured in gallons per minute (gpm).
19. Free Chlorine – The amount of chlorine available as dissolved gas, hypochlorous acid, or hypochlorite ion that is not combined with an amine or other organic compound.
20. Greensand – (See Manganese Greensand)
21. Influent – Water entering the inlet of the filter.
22. Installation – The piping and valving by which water filters are connected into the water supply system, including a drain line.
23. Intermittent Flow – Interrupted patterns of water usage. As used in this Standard, the term refers to specific on-off flow patterns selected to test performance under standard conditions, which may or may not be similar to actual operation of an installed filter.
24. Manganese Greensand – A processed natural alumino silicate, converted to the oxidized manganese form. This is a granular material, generally used for the removal of iron, manganese and/or sulfides, in oxidizing filters.
25. Manganese Zeolite – A processed natural, or synthetic alumino silicate, converted to the oxidized manganese form (see Manganese Greensand).
26. Media – The selected material in a filter that forms the barrier to the passing of certain suspended solids or dissolved molecules.
27. Micron – A linear measure of size: one millionth of a meter; denoted by the Greek letter symbol u. The micron is used in filtration work to define particle size and to measure the size of pores or openings. (1 micron = .00003937 inch).
28. Micron Rating – The particle size as stated by the manufacturer above which all suspended solids will be removed throughout its rated capacity. This is an "absolute", not a "nominal" rating.
29. mg/1 – Milligrams of matter per liter of water. This is approximately equal to parts per million in dilute solutions.
30. Neutralizer (Neutralizing Filter) – A filter type, mainly used to neutralize acidity and/or reduce free carbon dioxide in water.
31. Operating Pressure – The pressure range within which the equipment properly functions.
32. Particle Size – The size of a suspended particle as determined by its smallest dimension (this is usually expressed in microns).
33. Parts per Million (ppm) – A common basis of reporting water analysis in the United States and Canada. One part per million (ppm) equals 1 pound per million pounds of water; 17.1 ppm equals one grain per U.S. gallon; 14.3 ppm equals one grain per imperial gallon. (Approximate metric equivalent - milligrams per liter)
34. pH Value – A number denoting alkalinity or acidity. Numbers below 7.0 indicate acidity, which increases as the number becomes smaller. Numbers above 7.0 indicate alkalinity, which increases as the number becomes larger. The pH scale runs from 0 to 14, 7.0 being the neutral point.
35. Pre-Coat – The application of a loose filter medium to a supporting membrane.
36. Pressure Drop or Pressure Loss – A differential in pressure during flow due to resistance in the system. It may be expressed in pounds per square inch (psi) or feet of head (of water).
37. Rated In-Service Life – The length of time or total gallons delivered between servicing of the media, i.e., cleaning, regeneration, replacement, as specified by the manufacturer under standard WCF test conditions. (Synonymous with capacity)
38. Rated Pressure Drop – The pressure drop at rated service flow on clean 60° F. water with a clean filter.

39. Rated Service Flow – The manufacturer's specified maximum flow rate at which the filter will deliver quality water as specified for its type. (A manufacturer may also specify a minimum operating flow rate, or a range of Service Flows.)

40. Regeneration – In general, includes the maintenance steps (not necessarily in this order) of backwash, precoating and/or fresh water rinse or other treatment necessary to prepare or restore the filter for a service run.

41. Rinse – That part of the cycle of a water filter operation where water is introduced to remove spent backwash water or regenerant prior to placing the filter into service.

42. Service Run – That part of the operating cycle of a water filter in which the raw water supply is passed through a filter, thereby producing quality water.

43. Shielded (Insulated, such as by a dielectric union or fitting) – The separation of metallic parts by a nonconductor.

44. Suspended Matter – Undissolved material in water.

45. Toxic – Having an adverse physiological effect on man.

46. Turbidity – (1) A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays. (2) A measure of fine suspended matter in liquids. (3) An analytical quantity usually reported in arbitrary turbidity units determined by measurements of light scattering.

47. Validation – Determination by WCF that a prototype of the model validated has met the minimum performance requirements of this Standard, the manufacturer's performance ratings, and the requirements of non-toxicity of this Standard. All tests of performance standards and manufacturer's performance ratings shall be made pursuant to Section VII of this Standard. Certification by the National Sanitation Foundation that materials in contact with water meet NSF Standard 42 shall be sufficient evidence of compliance with the non-toxicity requirements of this Standard.

II PERFORMANCE STANDARDS

A. MECHANICAL FILTRATION – A mechanical filter shall for its rated capacity remove all* suspended solids down to the manufacturer's micron rating, when tested in accordance with Section VII. Such claim of a micron rating for a unit shall serve as the testing and validation criteria. Mechanical filters are further grouped by their capability of removing particulate solids as follows:

Groups	Micron Rating	Type	Function
V	Down to 60.0u	Utility Clarification	Coarse filtration and straining
IV	Down to 25.0u	General Household Quality	General household use (protect appliances from sediment)
III	Down to 5.0u	High Quality	Clean water for process and quality laundry water
II	Down to 1.0u	Premium Quality	Special potable beverages such as soda water, coffee water, reconstituting frozen drinks, ice
I	1.0u or below	Sub-Micron	Special application area not normally applied to household and commercial usage

(*"All" shall be interpreted as meaning within the detection limits of the specified Testing Procedures.)

B. ADSORPTIVE FILTRATION – Where the manufacturer claims chlorine taste and odor removal, a unit shall reduce an influent 3.0 mg/l free chlorine residual to an effluent less than or equal to 0.1 mg/l residual throughout its rated capacity at its rated service flow, when tested in accordance with Section VII. If mechanical filtration is claimed in addition to taste and odor removal, testing validation requirements of Paragraph II. A. shall also be met.

C. OXIDIZING FILTRATION – An oxidizing filter shall reduce 10.0±1.0 ppm of ferrous iron to not more than 0.2 ppm iron, 2±0.2 ppm manganous manganese to not more than 0.05 ppm

II. C. manganese, and 10.0±2.0 ppm sulfides as hydrogen sulfide to not more than 0.2 ppm hydrogen sulfide throughout its rated capacity at its rated service flow when tested in accordance with Section VII. If mechanical filtration is claimed in addition to oxidizing filtration, the testing and validation requirements of Paragraph II.A. shall also be met.

D. NEUTRALIZATION FILTRATION – By neutralizing acidity and/or reducing free carbon dioxide, a neutralizing filter shall produce a water with a minimum pH of 6.8 at its rated service flow throughout its rated capacity when tested in accordance with Section VII. If mechanical filtration is claimed in addition to neutralization, the testing and validation requirements of Paragraph II.A. shall also be met.

E. RATED SERVICE FLOW.

1. A Filter must maintain its specified effluent quality and micron rating during its rated capacity when flowing at manufacturer's rated service flow on intermittent operation, when tested in accordance with Section VII.
2. The rated service flow for any filter shall be as specified by the manufacturer.
3. Filters for single tap outlets shall have a rated service flow of not less than 1/2 gpm.
4. Filters for full line household use shall have a rated service flow of not less than 4 gpm.

F. RATED PRESSURE DROP

1. A filter must maintain its specified effluent quality and micron rating during its rated capacity when operating at maximum rated pressure drop or rated service flow under constant and intermittent operating conditions, when tested in accordance with Section VII.
2. The rated pressure drop for any filter shall be as specified by the manufacturer, but shall not exceed 10 psi at the Rated Service Flow with clean media and clean water at 60° F., when tested in accordance with Section VII.

III. MATERIALS AND CONSTRUCTION STANDARDS

A. GENERAL MATERIAL REQUIREMENTS

1. CONSTRUCTION
   - a. Materials shall be selected for their strength and resistance to corrosion by water and its normal contaminants, and regenerants, if any; shall be free of objectionable color throw, taste and odor; shall not impart toxic substances to the water.
   - b. Filters shall be designed and constructed so that when installed in accordance with the manufacturer's instructions they will meet established public health and safety requirements. Certification by a qualified testing laboratory that the filter meets requirements of NSF Standard 42 or equal shall be sufficient evidence of compliance with this sub-section. Regenerant tanks and connecting tubing, if any, are specifically exempted from the requirements of NSF Standard 42.
   - c. All non-metallic interior coatings or linings shall meet the requirements for plastic materials. All non-metallic components shall be constructed for a working temperature of at least 100°F. Unless exposed non-metallic components are capable of resisting, or are formulated to resist, deterioration due to sunlight, the manufacturer shall warn the installer and user against exposed installations.
2. CORROSION–RESISTANT MATERIALS – Corrosion-resistant materials will be accepted without coating of wetted surfaces. Presently accepted materials include: (1) approved copper alloys (including bronze and brass), (2) A1S1 type 300 series stainless steel, (3) monel, (4) synthetic (plastic) materials approved for use in contact with potable water.
3. NON-CORROSION-RESISTANT MATERIALS - Non-corrosion-resistant materials shall be provided with a properly applied adequate protective coating completely covering all wetted surfaces. Cathodic protection may be included as an additional means of preventing or reducing corrosion.

4. DISSIMILAR METALS – Dissimilar metals not normally considered compatible on the electromotive scale shall not be in direct contact with each other and with water in the filter.

5. ELECTRICAL – All electrical components shall be "approved" as defined in the 1968 National Electrical Code (published by the National Fire Protection Association). Electrical control devices which use Class 1 Systems, as defined in the National Electrical Code, shall be capable of withstanding the standard dielectric strength test of 1,000 volts plus twice the maximum rated voltage for a period of one minute. Flexible cords used to supply electrical power to clocks and/or control valves shall be of adequate size for the load but in no case smaller than AWG size 18 wire, shall incorporate a conductor for grounding purposes, and shall use an acceptable strain relief fitting at the case to prevent pull or strain on terminals or joints. The strain relief shall meet a test pull of 20 pounds. Tests shall be in accordance with Section VII.

B. WORKING PRESSURE AND HYDROSTATIC TESTS

1. HOUSEHOLD AND PORTABLE EXCHANGE FILTERS – All components subject to line pressure shall be constructed for a working pressure of at least 125 psig and the following hydrostatic requirements:

125
2.4
500
250
300 psi ?

   a. Complete filter assemblies shall withstand a hydrostatic test pressure of 2.4 times the working pressure (300 psi minimum) for a period of 15 minutes without leakage of water from the unit.

   b. Metallic pressure vessels shall withstand a hydrostatic test pressure of 2.4 times the working pressure (300 psi minimum) for a period of 15 minutes without excessive permanent distortion, defined as an increase in vessel circumference more than 0.2 per cent of the original circumference, or top or bottom head deflection more than 0.5 per cent of the tank diameter.

   c. Non-metallic pressure vessels shall have a burst pressure of at least four times the working pressure (500 psi minimum), and shall be water tight at 150 psi after a minimum of 100,000 pressure cycle of 0 to 150 psi at 70±5°F. Approval of a non-metallic vessel under this or an equal specification by a recognized testing agency shall be considered to be acceptable evidence of compliance with this section. Approval may be by a designated approval seal on a vessel, or by letter of certification.

   d. Valves and controls subject to line pressure, shall be water tight a 150 psi after a minimum of 100,000 pressure cycles of 0 to 150 psi at 70±5°F.

2. COMMERCIAL FILTERS – All components subject to line pressure shall be constructed for a working pressure of at least 100 psig and the following hydrostatic requirements:

   a. Complete filter assemblies shall withstand a hydrostatic test pressure of 1.5 times the working pressure (150 psi minimum) for a period of 15 minutes without leakage of water from the unit.

   b. Metallic pressure vessels shall withstand a hydrostatic test pressure of 1.5 times the working pressure (150 psi minimum) for a period of 15 minutes without excessive permanent distortion, defined as an increase in tank circumference more than 0.2 per cent of the original circumference, or top or bottom head deflection more than 0.5 per cent of the vessel diameter.

   c. Non-metallic pressure vessels shall have a burst pressure of at least 4 times the working pressure (400 psi minimum).

3. DISPOSABLE PRESSURE VESSELS – (i.e., those having an estimated one year operating life or less) and all replaceable components subjected to line pressure shall:

   a. Withstand a hydrostatic test pressure of 2.4 times the working pressure (300 psi minimum) for a period of 15 minutes without leakage of water from the unit.

   b. Be water tight to 150 psi and show no evidence of failure after being subjected to 10,000 low-high pressure cycles of 0 to 150 psi at 70±5°F.

125
2.4

4. FILTER MEDIA – All filter media shall withstand a pressure differential of at least 40 psi without breakdown which results in the passage of untreated water or contaminants into the filter effluent, when tested in accordance with Section VII.

IV. INSTRUCTION AND INFORMATION REQUIREMENTS.

A. OPERATION & INSTALLATION DATA – Instructions setting forth complete, detailed instructions for installation, operation, maintenance and initiation of service shall be provided with each unit. Specific instructions shall include arrangement of plumbing connections, electrical wiring where applicable, disinfection procedures and other requirements of this Standard, with details referring to the particular filter model. Installation instructions shall note the need for compliance with state and local laws and regulations.

1. In addition, the manufacturer of household and commercial water filters shall furnish the following minimum data with the filter for the users:
    - a. Model number
    - b. Classification and filter group
    - c. Functional description of unit
    - d. Rated service flow in gpm
    - e. Pressure drop at rated service flow
    - f. Micron rating
    - g. Capacity, with the following statement: "This capacity was determined under WCF Standard S-200 Test Conditions, and may vary with local water characteristics."
    - h. Maximum working and/or operating pressure, in psig.
    - i. Maximum operating temperature in degrees F.

B. DATA PLATE – A permanent plate or label shall be affixed in a conspicuous location on each unit. This label shall contain the following:

1. Model number
2. Name and address of manufacturer
3. Maximum working and/or operating pressure in psig
4. Maximum operating temperature in degrees F.
5. Electrical characteristics, where applicable.

C. MEDIA – Media specifically for replacement purposes, including but not limited to cartridges, shall be labelled with:

1. Model number, if used
2. Name and address of manufacturer
3. Validated ratings, such as micron rating, filter group category, Rated Service Flow, Rated In-Service Life or capacity
4. Operating or exchange steps, where appropriate.

V. MANUFACTURER'S SALES LITERATURE AND SPECIFICATIONS.

A. Published literature and specifications shall show the following as defined in these standards:

1. Validated micron ratings and filter group 2.
2. Validated service flow rates, capacity and pressure drop at the Rated Service Flow.

VI WARRANTIES

Deleted
July 1, 1977

VII. VALIDATION OF PERFORMANCE RATINGS.

A. HOUSEHOLD FILTERS.

1. Validation by Test; Standard Minimum Series. The following measurements and performance ratings shall be verified by actual tests by the Water Conditioning Foundation or other approved testing agency on at least one size of each model. ? WQA?
   a. Mechanical, Adsorptive, Oxidizing and/or Neutralizing performance
   b. Capacity
   c. Rated Service Flow
   d. Pressure Drop Curves
   e. Hydrostatic Tests on pressure vessels and media
   f. Dielectric Strength, where applicable
   g. 0 to 150 psig cycle tests, where applicable.
2. Validation by Calculation may be used to extend test results to other sizes of the same model. Filters may be considered the same model when they are identical in valving, internal design and construction, type of filter media, and operation, and vary only in the amount or surface of media and tank size, provided:
   a. The filter tank cross section area is not more than 200% or less than 50% of the tested filter tank;
   b. The media depth is not less than 80% of the depth of the tested filter;
   c. The Rated Service Flow in gpm per square foot of media cross section is not more than 120% of the Rated Service Flow of the tested filter;
   d. The backwash flow rate, where used, in gpm per square foot of media cross section is not less than 80% of the backwash flow rate of the tested filter; and,
   e. The Capacity per cubic foot of loose media or per square foot of fixed media ~~in~~ is not increased above that of the tested filter.

Why not test
the maximum for
a b & d and the
minimum for
c and e ?

3. Validation by Calculation procedures: The specifications of the filter to be Validated by Calculation shall be checked for conformance with the tolerances of Section 2, above, and the capacity and pressure drop ratings determined.
   a. Calculate the capacity ratings as proportional to the volume of loose media or cross sectional area of fixed media.
   b. Determine the pressure drop of the calculated filter by first plotting the corrected media pressure drops of the tested filter against flow rates in gpm per square foot on log-log graph paper. Express the increments of flow rate of the calculated filter in gpm per square foot and read the corresponding pressure drops from the graph. Correct these pressure drop values for variations in media depth by applying the following equation:

$$Pg \quad X \quad \frac{Bc}{Bb} \quad = \quad Pm$$

in which
Pg is the pressure drop from the graph,
Bc in the media depth of the calculated filter,
Bb is the media depth of the basic tested filter, and
Pm is the pressure drop through the media of the calculated filter.

VII. A. 3. b. Then, Pc + Pm = Pc in which
Pc is the pressure drop of the empty tested filter, and
Pc is the pressure drop of the filled calculated filter.

Plot of the calculated pressure drop values against such increment of flow rate in gpm on log-log graph paper, and determine the pressure drop at the Rated Service Flow.

c. Hydrostatic and cycling tests may be required at the discretion of the Water Conditioning Foundation.

B. COMMERCIAL FILTERS.

1. Validation by Test; Standard Minimum Series. The following measurements and performance ratings shall be verified by actual tests by the Water Conditioning Foundation or other approved testing agency on at least one size of each model.
   a. Pressure drop curve on empty filter
   b. Hydrostatic tests
   c. Dielectric Strength, where applicable
   d. 0 to 150 psig cycle tests, where applicable
   e. Calculation of capacity, pressure drop and service flow ratings, based on reliable data from the supplier of the media, tests on the same media in a household filter, or other source acceptable to the Water Conditioning Foundation.

   NOTE: It may be impractical to ship commercial filters with service flow ratings above 16 gpm to a central laboratory for verification of performance ratings by complete tests. In such cases, the performance tests listed above may be witnessed by the Water Conditioning Foundation, or other approved testing agency, at the plant of the equipment manufacturer or other suitable site.

2. Validation by calculation may be used to extend test results and calculated ratings from Paragraph B.1 above to other sizes of the same model, using the applicable restrictions and procedures of Paragraphs A.2 and A.3 above.

C. PORTABLE EXCHANGE FILTERS.

1. Validation by Test; Standard Minimum Series. The following measurements and performance ratings shall be verified by actual tests by the Water Conditioning Foundation or other approved testing agency on at least one size of each model, using new or conditioned filters as indicated:
   a. Mechanical, Adsorptive, Oxidizing and/or Neutralizing performance, on new filters
   b. Capacity, on new filters
   c. Rated Service Flow, on conditioned filters
   d. Pressure Drop Curves - One on empty new pressure vessel, three on filled conditioned filters.
   e. Hydrostatic tests on pressure vessels and media, on new filter
   f. 0 to 150 psig cycle tests, where applicable, on empty new filter. (Not the same as used for hydrostatic tests.)

2. Validation by Calculation may be used to extend test results to other sizes of the same model. Portable exchange filters may be considered the same model when they are identical in connectors, internal design and construction, and type of filter media, and vary only in amount or surface of filter media and tank size, provided:

   Why not?

   ? Test the minimum
   a. The filter tank cross section is not more than 200% or less than 50% of the tested filter tank;
   b. The media depth is not less than 80% of the depth of the tested filter;

   ? Test the maximum
   c. The Rated Service Flow in gpm per square foot of media cross section is not more than 120% of the Rated Service Flow of the tested filter;

   d. The In-Service Life or Capacity per cubic foot of loose media or per square foot of fixed media is not increased above that of the tested filter.

3. Validation by Calculation procedures: The specifications of the filter to be Validated by Calculation shall be checked for conformance with the tolerances of Section 2, above, and the in-service life or capacity and pressure drop ratings calculated using the applicable restrictions and procedures of Section A above.

D. ORDER OF TESTS.

1. Where all tests are to be run on one filter, the order of tests shall be as follows:
   a. Pressure drop curve of filter without media
   b. Adsorptive performance and capacity
   c. Oxidizing performance and/or capacity
   d. Neutralizing performance or capacity
   e. Mechanical performance or capacity
   f. Pressure drop curve with media in place
   g. Hydrostatic Tests on pressure vessels and media
   h. Dielectric Strength, where applicable
   i. 0 to 150 psig cycle tests, where applicable.
2. Where total elapsed time or other factors must be considered, duplicate components or assemblies may be used to permit concurrent tests, as in the case of Portable Exchange Filters.

E. PRESSURE DROP

1. Apparatus.

   a. Manometer.
   Mercury Manometer, Merriam Model 20AA25WM, or equal. A 70" manometer will permit the measurement of up to approximately 30 psi differential pressure. Permanently mount the manometer in a plumb position.

   Traps should be installed in the pressure lines to the manometer, to prevent water from reaching the mercury columns, and to catch the mercury if it is inadvertently blown from the manometer. The traps may be conveniently constructed from 2" pipe, approximately 24" long. Holes may be drilled and tapped in the caps and side walls for the drain and shut-off cocks and pressure lines to the mercury columns. Refer to schematic Figure 1 – Page 13.

   Connecting tubing may be 1/4" O.D. copper tubing, or of plastic tubing, with appropriate fittings.

   Redistilled mercury, suitable for instrument use, must be used.

   b. Pressure Tap Assemblies.
   Pressure taps shall be installed in pipe nipples of the proper diameter to be directly connected to the inlet and outlet ports of the unit under test, without the use of reducers or bushings. Couplings are permitted in the case of male inlet or outlet threads.

   The outlet nipple shall be of sufficient length to permit installation in the test unit without interference with the inlet nipple, when inlet and outlet ports are on minimum centers.

   The pressure taps shall be located not less than three times the nominal inside diameter (3 x D) of the pipe nipple from either end of the nipple. See schematic Figure 3 – Page 13.

   The pressure taps shall be by use of fittings or adapters fastened to the pipe in such a way that the fittings do not extend beyond the inner wall of the pipe. See schematic Figure 2 – Page 13.

VII. E. 1. b. The size of the pressure tap hole through the pipe wall shall not exceed the dimensions given below:

Nominal Inside Pipe Diameter d"	Maximum Pressure Hole Diameter d"
Less than 1 1/2"	1/8"
1 1/2" or more	1/4"

The length of the pressure hole measured from the inner surface of the pipe shall not be less than three times the diameter of the pressure hole (3 x d). See schematic Figure 2 – Page 13.

There shall be no burrs, wire edges, or other irregularities on the inside of the pipe at the pressure connections or along the edge of the hole through the pipe wall.

c. Flow Meter.

Shall be a direct reading flow meter of the type manufactured by Fischer & Porter and Brooks Rotameter Company, with an accuracy of plus or minus 2% of full flow, or equal. An orifice plate flow meter of equal accuracy may be used if desired. A range of 2 to 20 gpm will cover tests for Household and Portable Exchange Filters, but tests on Commercial Filters will require higher capacities.

Install the flow meter in a permanent plumb position in accordance with the instructions of the manufacturer. Avoid the excessive use of reducers and bushings.

d. Pressure Gauge.
Install a pressure gauge in the outlet of the flow meter. The pressure of the test water line must be at least 30 psi at full test flow.

e. Thermometer.
A Fahrenheit thermometer suitable for installation in the water line is recommended. Alternately, a glass portable thermometer may be used to check the temperature of the test water. Graduations shall not be more than 2°F. apart.

f. Connecting Hoses.
Connecting hoses may be used for the water supply to the test unit, and for the outlet line to the drain. The hose should have an I.D. of at least 1", and in no case should be smaller than the filter inlet and outlet.

g. General Assembly of Apparatus.
The specific components listed above plus necessary incidental fittings shall be assembled in the following sequence:

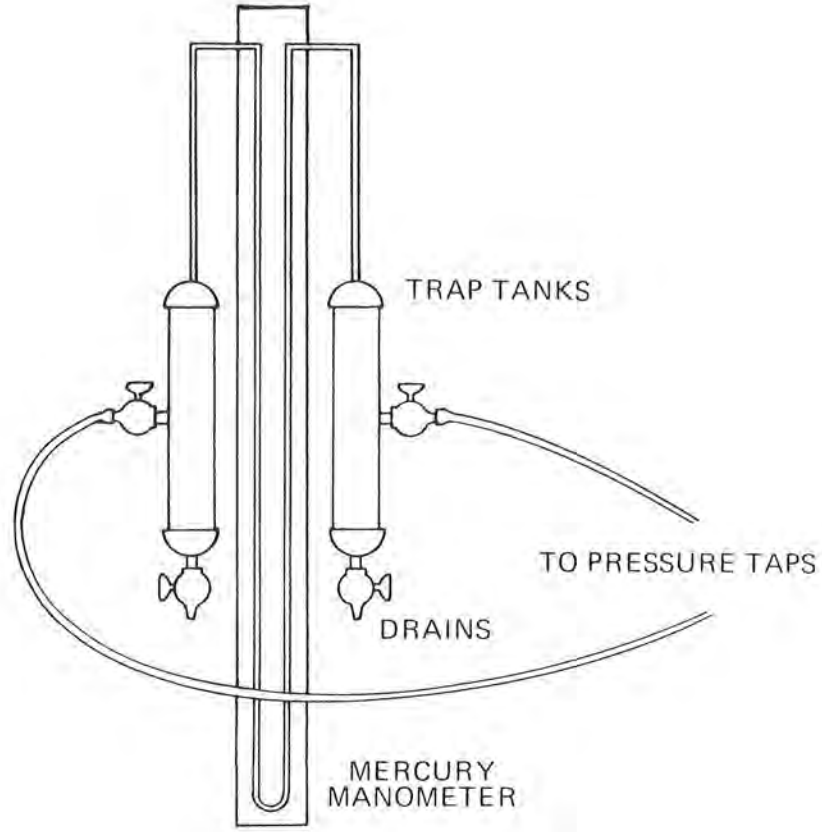
Inlet water line
Inlet valve
Thermometer
Flow meter
Pressure gauge
Connecting hose
Inlet pressure tap assembly
Unit under test
Outlet pressure tap assembly
Throttling valve
Hose to drain.

Install the connecting tubing between the manometer traps and the pressure taps.

NOTE: At no time shall brass or copper be used where it may be in contact with the mercury, as amalgamation may result.

2. TEST PROCEDURE.

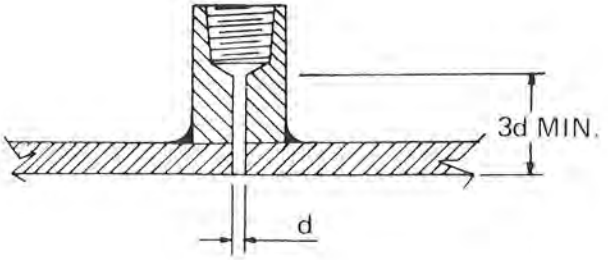
a. With the test unit installed as in 1.g., close the manometer drain and shutoff cocks. Open



Install the connecting tubing between the manometer traps and the pressure taps.

Note: At no time shall brass or copper be used where it may be in contact with the mercury, as amalgamation may result.

FIG.1



NOTE:
EDGE OF HOLE MUST BE
CLEAN AND SHARP OR
SLIGHTLY ROUNDED,
FREE FROM BURRS,
WIRE EDGES, OR OTHER
IRREGULARITIES.

FIG.2

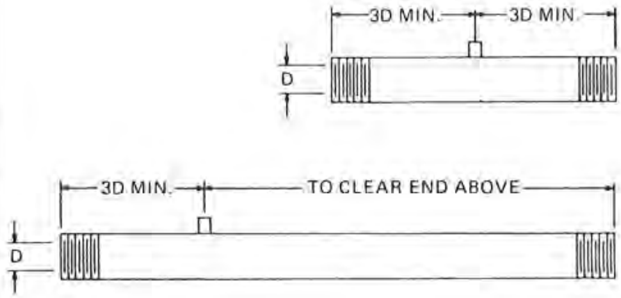


FIG.3

the throttling valve and slowly open the inlet valve to fill the test unit with water. Flush the system thoroughly to eliminate air pockets. Close the outlet valve.

b. If the test unit is a filter containing loose media, backwash or regenerate the unit in place. Avoid jarring or other disturbance. Then place the filter valving in service position.

c. Open the manometer shutoff cocks simultaneously to apply pressure to both legs of the manometer. Allow the two manometer mercury columns to reach equilibrium.

d. Adjust the position of the manometer scale to bring both the mercury columns to the zero position, if possible. If not possible, record the initial column readings at zero flow.

e. With the throttling valve, adjust the flow through the test unit in increments of approximately 2 gpm for household filter tests. Other increments may be used if desirable for special investigations or other types of units. A minimum of four readings is necessary, and five or more is recommended. Record the mercury levels of both columns to the closest 0.1 inch, at each increment of flow.

f. Readings shall be continued until the rated service flow is exceeded by at least 2 gpm. Readings may be further continued until the maximum of the flow meter has been reached, or the mercury in the manometer has reached an unsafe level.

g. At the conclusion of the test, slowly close the inlet valve. When the pressure in the system has dropped to zero, open the manometer trap drain cocks and disconnect the test unit.

3. Calculation of Results

a. Add the mercury level readings of the left and right columns to determine the total mercury differential at each flow rate. Subtract the sum of the initial mercury readings at zero flow from each total.

b. Multiply each total mercury differential by 0.489 to convert from inches of mercury to pounds per square inch.

c. As the viscosity of water affects the pressure drop through a bed of media, and the viscosity changes with water temperature, it is necessary to make a correction of the observed pressure drop of a filter containing the media.

To express the pressure drop at the standard temperature of 60°F. apply the following equation to the observed differential in psi at each increment of flow:

$$Pb = Pt + F\ (Pf - Pt)$$

in which Pb is the pressure drop of the tested filter, corrected to 60°F.,

Pt is the pressure drop of the empty filter at the same flow rate,

Pf is the observed pressure drop at the filter containing the media at the same flow rate, at T°F., and

F is the correction factor from the following table.

Test Water Temperature T° F.	Correction Factor	Test Water Temperature T° F.	Correction Factor
46	0.81	66	1.09
47	0.82	67	1.10
48	0.83	68	1.12
49	0.85	69	1.13
50	0.86	70	1.15
51	0.87	71	1.16
52	0.89	72	1.18
53	0.90	73	1.19
54	0.91	74	1.21
55	0.93	75	1.22
56	0.94	76	1.24
57	0.96	77	1.26

58	0.97	78	1.27
59	0.99	79	1.29
60	1.00	80	1.31
61	1.01	81	1.32
62	1.03	82	1.34
63	1.04	83	1.35
64	1.06	84	1.37
65	1.07	85	1.38

F. GENERAL TEST APPARATUS FOR MECHANICAL, ADSORPTION, OXIDATION AND NEUTRALIZATION PERFORMANCE, AND CAPACITY.

1. The test apparatus shall be arranged as shown in Figure 4 – Page 16, or equal, to provide for the introduction of artificial contaminants for specific tests. The following specific pieces of equipment shall be included:
   - a. A chemical feed pump system for the proportional introduction of contaminants.
   - b. A pressure control system such as a pressure regulator or pressure relief valve to provide 50 psig pressure on the test filter;
   - c. A recirculating or stirring system to insure mixing of contaminants with the feed water and to keep artificial turbidity in suspension;
   - d. A flow meter in the inlet line to indicate the flow rate in gallons per minute;
   - e. A sampling valve or system in the inlet line to provide representative samples of the feed water;
   - f. A water meter calibrated in U.S. Gallons;
   - g. A sampling valve or system in the outlet line to permit collection of filtered water samples;
   - h. Accurate pressure gauges in the inlet and outlet lines to detect excessive pressure differentials;
   - i. A Solenoid valve in the outlet line which can be opened continuously for an entire test run, or cycled for an intermittent flow test; and,
   - j. A throttling valve or flow control in the outlet line. A throttling valve has the advantage of ready adjustment, but the disadvantage of declining flow as back pressure develops in a filter. A flow control has the advantage of steady flow, but the disadvantage of specific flow rate. Thus the flow control must be changed for each flow rate as desired.
2. Feed Water. Before the addition of the synthetic contaminants, the water to the test apparatus shall:
   - a. Have a temperature of 65 to 75° F.;
   - b. Have a pH of 7.0 to 8.0;
   - c. Have a turbidity of less than 1 JTU (Jackson Turbidity unit); and
   - d. Be free of organic matter which would interfere with the tests.

∴ Are we not talking about applications to require water that may disinfection!

? will Water in field conditions be "free of organic matter? ~~[illegible]~~ what interference will organic matter have?

G. MECHANICAL FILTRATION TEST PRODEDURE.

1. Install the test filter in the apparatus in Section F, following the manufacturer's standard installation instructions, including backwashing or other preliminary operations.
2. Set the cycle timer to open the outlet solenoid valve for 5 minutes and to shut the valve for one minute in a repeating cycle.
3. Start the contaminant feed system and adjust to maintain a turbidity of 5.0±0.5 Jackson Turbidity Units in the feed water.
   - a. Use AC Coarse Test Dust for filters in Groups IV and V.
   - b. Use AC Fine Test Dust for filters in Groups II and III.
   - c. Use dioctyl phtalate (range about 0.3 micron), iron oxide (range 0.5-5 microns. Military Spec. MIL-E-5007B) or other suitable material for Group I filters.

For Disinfection, also maintain ≥ 500 HPC organisms/100 ml in feed H_2O and ≥ 5 Total coliforms organisms/100 ml

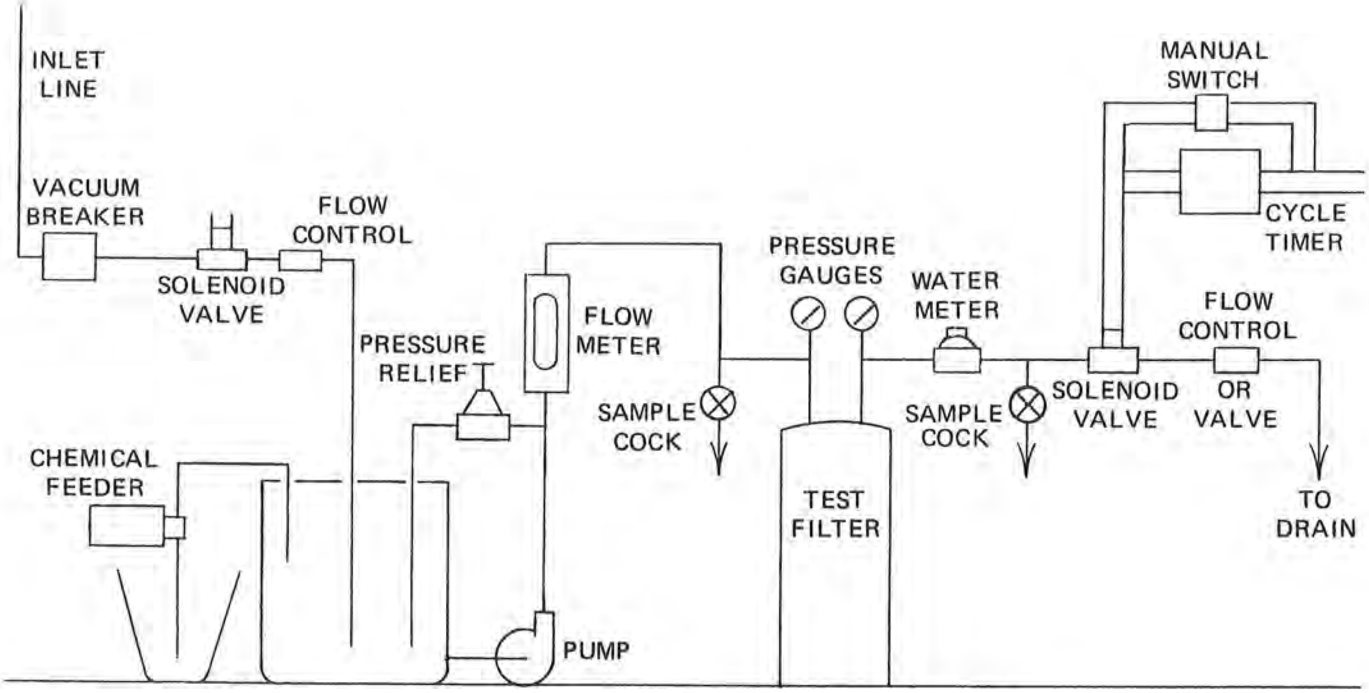

INLET LINE
MANUAL SWITCH
VACUUM BREAKER
FLOW CONTROL
CYCLE TIMER
PRESSURE GAUGES
SOLENOID VALVE
WATER METER
FLOW METER
FLOW CONTROL
PRESSURE RELIEF
SAMPLE COCK
SAMPLE COCK
SOLENOID VALVE
OR VALVE
CHEMICAL FEEDER
TEST FILTER
TO DRAIN
PUMP

FIG.4

4. Record the initial meter reading and the time, and start the flow through the filter at the manufacturer's specified Rated Service Flow. Record the initial pressure drop across the filter at the Rated Service Flow.
5. Periodically or continuously collect samples of the feed water and determine the turbidity to insure control within the limits of 5.0±0.5 JTU. Measure the turbidity in accordance with the procedures in "Standard Methods for the Examination of Water and Wastewater", current edition. The Hach Model 2100A Turbidimeter is suitable for this purpose.
6. Periodically collect samples of the effluent and check both turbidity, as above, and the size of the particles present. Collect at least six samples immediately after the solenoid valve has been turned on, to detect possible "slugs" of turbidity. Determine the size of the particles present by the following procedure:
   a. Select an appropriate sieve of Millipore membrane for use in the particle size range of the filter Micron Rating.

      U.S. Standard and/or ISO Standard sieves are available in 88,74,63,53,44 and 37 micron sizes. Special sieves are available (Fischer Scientic Co.) in 30,20 and 10 micron sizes.

      Millipore membranes are available in pore sizes from 14 to .025 microns.
   b. Filter the collected effluent samples through the selected sieve or membrane. A minimum of 2 gallons shall be filtered when sieves are used, a minimum of 500 ml shall be filtered when membranes above 1.0 micron are used, and a minimum of 100 ml shall be filtered when membranes 1.0 micron or less are used.
   c. If a sieve is used, it may be desirable to transfer any retained particles from the sieve into a suitable container, and then to a Millipore membrane, using turbidity-free water, for direct visual or microscopic examination.
   d. If the sieve or membrane used is the same size as the Micron Rating of the filter being tested, the presence of any particles on the sieve or membrane constitutes a failure, and a larger Micron Rating must be established.
   e. If a sieve or membrane of the same pore size as the Micron Rating of the filter is not available, use a sieve or membrane with a smaller pore opening, and determine whether or not excessively large particles are present by examination with a calibrated microscope.
7. The end of the test will be determined by one of the following conditions:
   a. The manufacturer's Capacity is reached.
   b. The effluent turbidity contains particles larger than the rating.
   c. The Pressure Drop across the filter increases 10 psi above that at the start of the test.

for Disinfection = effluent water contains any total coliform organisms or ~~[illegible]~~ any (?) HPC organisms per 100 ml

H. ADSORPTION FILTRATION TEST PROCEDURE

1. Install the test filter in the apparatus in Section F, following the manufacturer's standard installation instructions, including backwashing or other preliminary operations.
2. Set the outlet solenoid valve for continuous operation.
3. Start the contaminant feed system and adjust to maintain a free chlorine concentration of 3.0±0.3 ppm chlorine. 227 ml of sodium hypochlorite bleach, 5.25% available chlorine, per 1000 gallons of water will provide approximately the desired concentration.
4. Record the initial water meter reading and the time, and start the flow through the filter at the manufacturer's specified Rated Service Flow. Record the initial pressure drop across the filter at the Rated Service Flow.
5. Periodically collect samples of the feed water and determine the chlorine concentration to insure control within the limits of 2.7 to 3.3 ppm free chlorine. Determine the chlorine concentration in accordance with "Standard Methods for the Examination of Water and Wastewater", current edition.
6. Periodically collect samples of the effluent and determine the free chlorine concentration as in Paragraph 5. Collect at least twelve effluent samples during the course of the test run.
7. The end of the test will be determined by one of the following conditions:

VII. H. 7. a. The manufacturer's Capacity is reached.

- b. The free chlorine in the effluent exceeds 0.1 ppm.
- c. The Pressure Drop across the filter increases 10 psi above that at the start of the test.

I. OXIDIZING FILTRATION TEST PROCEDURE.

1. Install the test filter in the apparatus in Section F, following the manufacturer's standard installation instructions, including backwashing or other preliminary operations.
2. Set the outlet solenoid valve for continuous operation.
3. Start the contaminant feed system and adjust to maintain the desired concentration. Note that three test runs will be required, one for each of the following materials:
   - a. 10±1.0 ppm Iron, as Fe, using ferrous sulfate as the synthetic contaminant. It may be necessary to protect the surface of the solution in the chemical feeder solution tank and the feed water in the open feed tank with floating plastic to minimize oxidation of the ferrous iron.
   - b. 2.0±0.2 ppm Manganese, as Mn, using manganous sulfate as the synthetic contaminant. As in Paragraph a, protect the solutions against air.
   - c. 10.0±2.0 ppm sulfides, as hydrogen sulfide, using sodium sulfide as the synthetic contaminant. As in paragraph a, protect the solutions against air.
4. Record the initial water meter reading and the time, and start the flow through the filter at the manufacturer's specified Rated Service Flow. Record the initial pressure drop across the filter at the Rated Service Flow.
5. Periodically collect samples of the feed water and determine the concentration of the contaminant to insure control within the required limits. For these determinations, use procedures given in "Standard Methods for the Examination of Water and Wastewater", current edition.
6. Periodically collect samples of the effluent and determine the concentration of the contaminant as in Paragraph 5. Collect at least six effluent samples during the course of the test run. Note that sulfide samples must be analyzed promptly or else stabilized with zinc acetate to insure accurate results.
7. The end of the test will be determined by one of the following conditions:
   - a. The manufacturer's Capacity is reached.
   - b. The Iron concentration in the effluent exceeds 0.2 ppm = 98% removal, the Manganese concentration in the effluent exceeds 0.05 ppm, or the sulfide concentration in the effluent exceeds 0.2 ppm.
   - c. The Pressure Drop across the filter increases 10 psi above that at the start of the test.

J. NEUTRALIZATION FILTRATION TEST PROCEDURE

1. Install the test filter in the apparatus in Section F, following the manufacturer's standard installation instructions, including backwashing or other preliminary operations.
2. Set the outlet solenoid valve for continuous operation.
3. Start the contaminant feed system and adjust to provide a total alkalinity (Methyl Orange alkalinity) of 110±10, as calcium carbonate. (Lake Michigan has a natural alkalinity in this range. If necessary, use dealkalinization and/or a sodium bicarbonate feed to produce such a water). Then initiate a feed of hypochloric acid to reduce the pH to 6.1±0.1. This will result in a free carbon dioxide concentration of approximately 40 ppm as CO_2.
4. Record the initial water meter reading and the time, and start the flow through the filter at the manufacturer's specified Rated Service Flow. Record the initial pressure drop across the filter at the Rated Service Flow.
5. Periodically collect samples of the feed water and check the pH to insure control within the limits of 6.0 to 6.2. Determine the pH in accordance with "Standard Methods for the

Examination of Water and Wastewater", current edition.

6. Periodically collect samples of the effluent and determine the pH as in Paragraph 5. Collect at least twelve effluent samples during the course of the test run.
7. The end of the test will be determined by one of the following conditions:
   a. The manufacturer's In-Service Life or Capacity is reached.
   b. The pH of the effluent falls below 6.8.
   c. The Pressure Drop across the filter increases 10 psi above that at the start of the test.

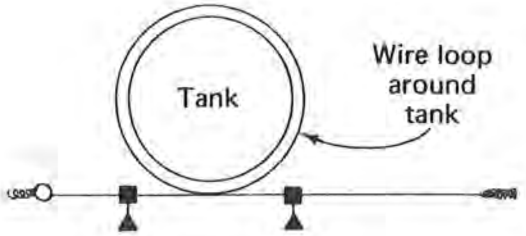
K. MEDIA STRENGTH TEST PROCEDURE.

1. Install the test filter in the apparatus in Section F. This test is conveniently done after the completion of the last of the Performance and Capacity test.
2. With water flowing through the test filter, feed sufficient synthetic turbidity to develop a pressure differential of 40 psi across the filter.
3. Collect effluent samples and determine turbidity and particle sizes as in the mechanical performance test, to detect the breakdown of the media or the passage of turbidity into the effluent.

L. HYDROSTATIC TESTS.

1. Test apparatus and arrangement.
   a. Hand pump, complete with check valves, capable of producing 300 psig pressure.
   b. Bourdon tube pressure gauge, graduate in increments of not more than 5 psi, with ± 2% accuracy.
   c. Micrometer caliper accurate to .001 inch; a range of 0 to 10 inches is recommended.
   d. Extensometers, accurate to .001 inch.
   e. Strong but flexible wire, such as stranded picture wire, with metal blocks which can be fixed in position on the wire. Round bar stock approximately 1 inch long, with a longitudinal hole for the wire, and a transverse threaded hole with a set screw, is suitable for this purpose. One length of wire with two blocks will be required for each foot or fraction of a foot of tank sidewall height.
   f. Shutoff valves and plugs.
   g. Connect the water supply to the inlet of the pump, and install the pressure gauge in the outlet of the pump.
2. Test procedure for non-metallic tank filters and disposable filters.
   a. Close the outlet of the filter with a suitable valve, and connect the filter to the outlet of the pump.
   b. Fill the system and test unit with water in the temperature range of 55 to 75°F., and flush to avoid pockets of air.
   c. Close the outlet valve, and gradually raise the hydrostatic pressure until 300 psig, or the rated test pressure of the unit if higher than that value, is reached.
   d. Maintain the test pressure for 15 minutes, with periodic inspections of the filter for leaks. Any leakage of water from the filter constitues a failure.
   e. Slowly open the outlet valve, with the water supply shut off, to bleed the pressure from the filter and system. Disconnect the filter.
3. Test procedure for metallic tank filters.
   a. Install the test filter on the elevated rack or stand, and position the extensometers vertically against the tank bottom head, and the top of the filter tank, top-mounted valve, or other solidly mounted upper component.
   b. Slide two of the movable blocks onto a length of flexible wire, and fasten one end of the wire to a solid post adjacent to the filter approximately 6 inches above the base of the

VII. L. 3. b. filter tank. Loop the wire around the filter and fasten the free end to a spring, or through a pulley to a suspended weight. Adjust the wire so that it makes the smallest possible loop around the tank and is in the same horizontal plane as the fastenings on both ends. Slide the movable blocks into position adjacent to the filter and tighten the set screws. A 6 to 8" space between the blocks is suitable for most household filter tanks.



c. Repeat step b with additional wires and blocks at not more than 12" intervals up the side sheet of the tank.

d. Proceed with steps 2a and 2b as with non-metallic tanks.

e. With no pressure on the filter, take initial readings from the extensometers, and measure the distances between the movable blocks on each wire, using the micrometer caliper.

f. Proceed with steps 2c and 2d as with non-metallic tanks. ≥ 300 psig for 15 minutes

g. Close the inlet valve and slowly open the outlet valve to bleed the pressure from the filter. Repeat the readings of the extensometers and the distances between the movable blocks on the wires. Note: A decrease in the distance between blocks indicates an increase in tank circumference.

M. DIELECTRIC STRENGTH TEST.

1. Application. This test shall be applied to electrical control and operating devices, including but not limited to electrical timers, solenoid valves, motor driven valves, and associated wiring and connections, to check the safety of the assembled electrical system as used on the filter.

2. Apparatus.

   a. Hi-Pot tester, of the type available from Associated Research, Inc., and Ideal Industries, Inc.

   b. Insulating stand, platform or blocks of wood or other material which will completely insulate the filter from the ground.

3. Procedure.

   a. Place the complete filter on the stand, platform or blocks, so that it will be completely insulated from ground, including the floor and electrical or plumbing connections.

   b. Connect the leads of the tester to appropriate terminals or components as indicated below, turn on test, increase the applied potential gradually from zero to the required test value of 1000 volts plus twice the maximum rated voltage of the equipment, and hold the voltage at that point for one minute. Any indication of leakage (of more than 0.5 milliampere), breakdown, arcing or corona, by the tester shall constitute a failure.

   c. A complete test shall include individual tests

      1. Between uninsulated live metal parts and the enclosure with the contacts open and closed.
      2. Between uninsulated live metal parts of different circuits.
      3. Between the live circuit and ground, and
      4. Between terminals of opposite polarity with the contacts closed. For this last test, transformers, coils or similar devices normally connected between lines of opposite polarity are to be disconnected from one side of the line during the test.

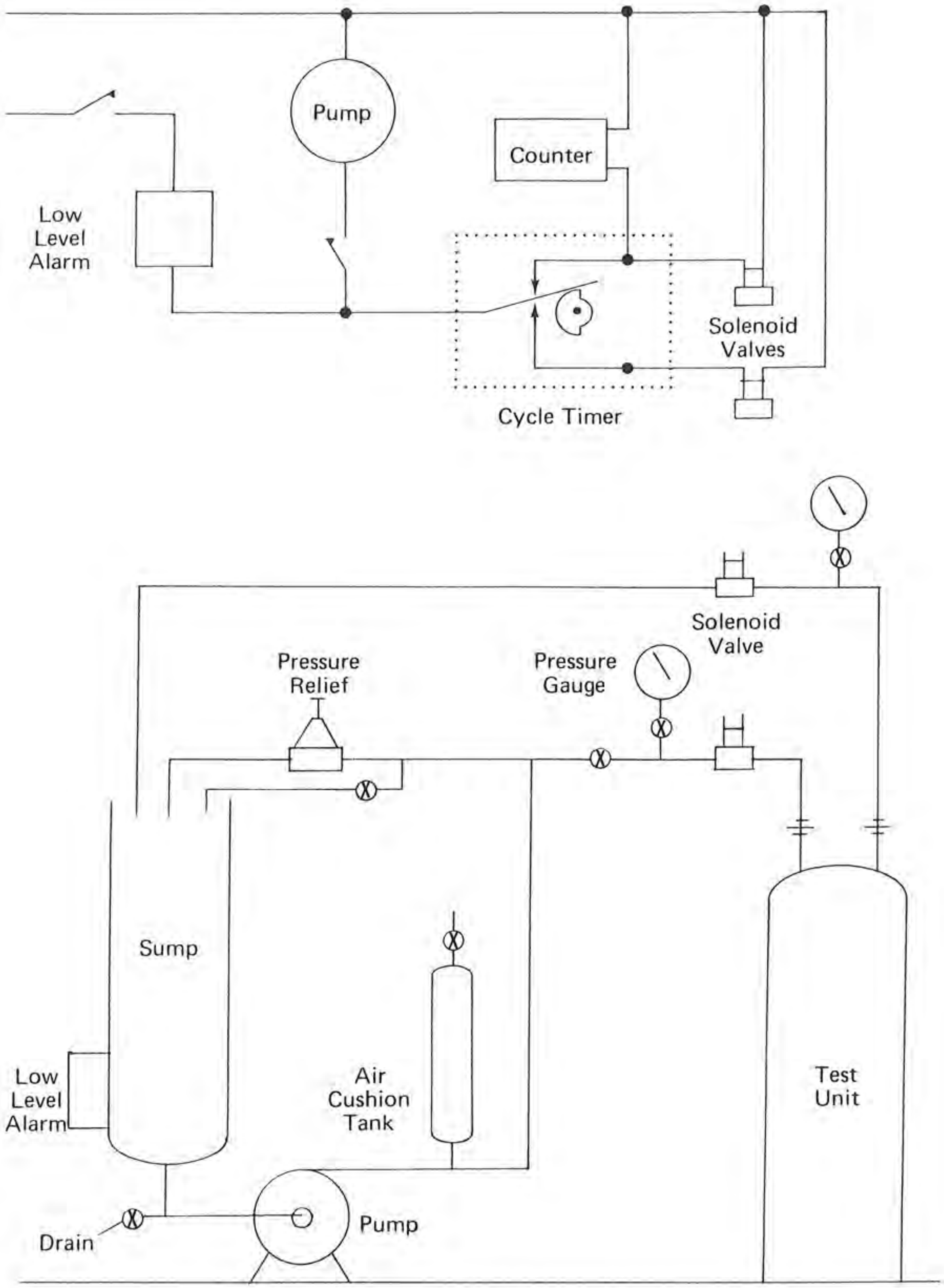

Pump
Counter
Low
Level
Alarm
Solenoid
Valves
Cycle Timer
Solenoid
Valve
Pressure
Relief
Pressure
Gauge
Sump
Low
Level
Alarm
Air
Cushion
Tank
Test
Unit
Drain
Pump

FIG.5

N. 0 to 150 PSIG CYCLE TEST.

1. Application. This test shall be applied to complete filter assemblies or to individual components as necessary to demonstrate compliance with the cycle test requirements for non-metallic components subject to line pressure.
2. Apparatus. Assemble the following components as shown in Figure 5 – Page 21.
   a. Open sump equipped with a low level alarm and switch to open the electrical circuit in the event of failure of the test unit.
   b. Positive displacement or centrifugal pump capable of maintaining 150 psig in pressure system during the test.
   c. Pressure relief valve for operation in 150 psig range.
   d. Solenoid valves for operation at 150 psig.
   e. Pressure gauges for operation at 150 psig, with ± 2% accuracy.
   f. Air cushion tank or column.
   g. Electrical impulse counter with capacity of at least 100,000 cycles.
   h. Continuous cycling adjustable cam timer with 1 revolution every 5 seconds.
   i. Bleeder valves for adjustment of pressure increase rate.
3. Procedure.
   a. Fill the test unit with tap water at room temperature and connect to the test apparatus as shown in Figure 5 – Page 21.
   b. Fill the sump with tap water at room temperature and operate the system at low pressure to bleed air from the test unit.
   c. Set the counter at zero, or record initial reading. Adjust the cam cycle timer, pressure relief valve and bleed valves to produce a pressure cycle from 0 to 150 psig in 1.5 seconds, maximum pressure for just an instant, and an immediate release of pressure. The pressure in the test unit shall return to zero psig before the initiation of another cycle.
   d. Continue the 0 to 150 psig cycling, with periodic inspections of the test unit and cycle, until 100,000 cycles have been completed or 10,000 cycles for disposable filters. 100,000 cycles will require approximately 139 hours or 5.8 days of continuous operation.
   e. Stop the cam cycle timer so that 150 psig pressure is on the test unit and inspect the unit for leaks. Any evidence of leakage during the cycle tests or in the final inspection shall constitute a failure of the unit.

O. BURST TESTS FOR NON-METALLIC TANKS.

1. The following test is normally conducted by the tank manufacturer, and conformance with the burst pressure requirements may be by certification by the tank manufacturer.
2. Test procedure.
   a. The tank to be tested shall be a complete unit, assembled if necessary to conform to its normal state of use.
   b. The tanks shall be connected to a water supply thru a pump system incorporating a Bourdon tube pressure gauge with a minimum reading hand or equal, a check valve, a shut-off valve and a drain valve. High Strength fittings are to be used for the system subject to the high pressure.
   c. All remaining tank openings shall be closed by the use of high strength threaded fittings, where possible. Provision shall be made for flushing the tank to free it of air.
   d. A shield or enclosure shall be provided to protect the operator.
   e. The entire system shall be filled with water at room temperature, and flushed to avoid the pocketing of air.
   f. With all outlets closed, the hydrostatic pressure shall be steadily raised at a rate of 80 to 100 psi per second until the specified burst pressure is reached, or rupture or fracture of the tank occurs.

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Water Quality Association
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4151 Naperville Road
Lisle, Illinois 60532
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Printed in U.S.A.
4/88